H_2 production by photo-electrochemical conversion of urea on electrodeposited Fe_2O_3/Ni photoanodes

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The photoelectrochemical conversion of urea can be achieved in alkaline medium through the reaction:
$CO(NH_2)_2 + H_2O + solar\text{-}h\nu + electrochemical\text{-}\Delta V \rightarrow CO_2 + N_2 + 3\,H_2$ *(R1)*
Producing H_2 from *R1* requires three times less energy than from water splitting, (thermodynamic cell potential of 0.37 V *vs*. 1.23 V, respectively). The vast untapped resource of urea in urine (60 Mt/year from humans) makes *R1* very attractive as converting pollutant into fuel with the assistance of solar energy simultaneously addresses the problematics of (1) wastewater treatment, (2) production of H_2 as an energy vector and (3) energy saving by use of renewable energies.

Urea electro-oxidation has been the subject of numerous studies [1] but only three works have been published so far on the photo-electro-oxidation of urea [2-4]. In this context, our goal is to design and study photoanodes for efficient conversion of solar energy (UV-Visible) to obtain high oxidation photocurrents in the presence of urea. For this purpose, we have synthesized Fe_2O_3 semiconductor layers, decorated with Ni-metal nanocatalysts. First, a Fe^0 deposit is obtained on a Fluorine-doped Tin oxide (FTO) glass by electrodeposition from a Fe^{II} salt solution. The samples are doped with Pt or Sn by adding to the Fe^{II} salt solution either H_2PtCl_6 or $SnCl_2$ at various concentrations. The deposit is then annealed at 700°C for 2 hours to obtain Fe_2O_3. At that point, nickel nanoparticles are electrodeposited on Fe_2O_3 and the resulting FTO/Fe_2O_3/Ni materials are characterized by X-Ray Diffraction and Scanning Electronic Microscopy to identify their structure and morphology. Then, the photoelectrochemical performances toward urea oxidation were determined by voltammetry under illumination. We will present these results and the context of hydrogen production based on the developed urea oxidation process.

References

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